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A Handbook of Pesticide Chemicals for Forest Use

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A HANDBOOK OF PESTICIDE CHEMICALS
FOR FOREST USE

BY

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Prepared for the United States Forest Service
Short Course for Pesticide Applicators

INTRODUCTION

This handbook serves the purpose of collecting in a brief form the essential information about the pesticide chemicals that have been commonly used or are considered for use in forest management. Not all the chemicals herein have been labeled for use on forest lands and with implementation of the 1972 Federal Environmental Pesticide Control Act, with its prohibition on non-label pesticide uses, some of these chemicals will not be available for use. In addition, administrative rulings may change the status of some of the chemicals. Much of the information presented here is available in various compilations or handbooks which cover the entire array of pesticide chemicals. Since foresters are interested in only a limited number of chemicals, this short array should prove to be a convenience. In addition, the larger compilations are oriented to agricultural use rather than forest use and much of the information presented is not pertinent. This compilation is not intended to present directions for application or recommendations for use, but only to present certain basic information about the pesticides used in the forest.

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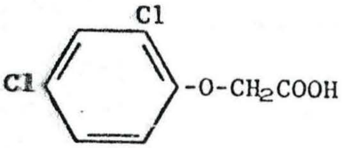
SUMMARY OF CHEMICAL CLASSIFICATION

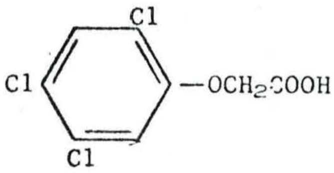
I. Herbicides

A. Phenoxy Acids

2,4-D


Cl
Cl
-O-CH2COOH

2,4,5-T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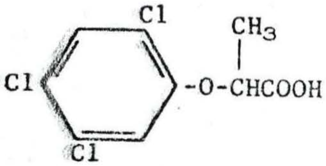
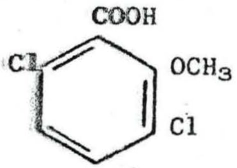
Cl
—OCH2COOH
Cl

Silvex


Cl
CH3
Cl
-O-CHCOOH
Cl

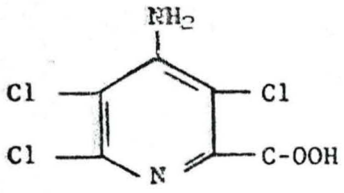
B. Benzoic Acid

Dicamba

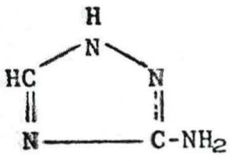

COOH
Cl
OCH3
Cl

C. Nitrogen Heterocyclics

Picloram



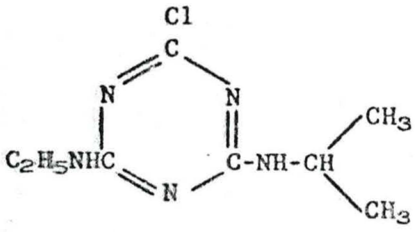
Amitrole



Amitrole-T

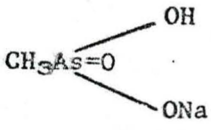
Amitrole + NH_4SCN

Atrazine

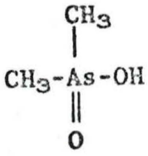


D. Arsenicals

MSMA



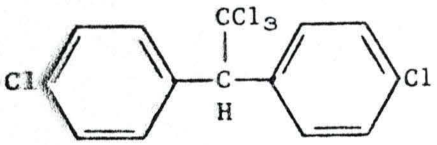
Cacodylic Acid



I. Insecticides

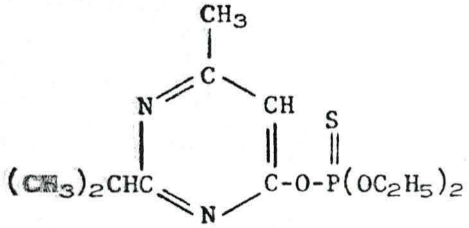
A. Chlorinated Hydrocarbon

DDT

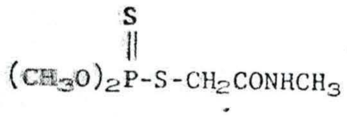


B. Organo and Phosphorous Ester

Diazinon

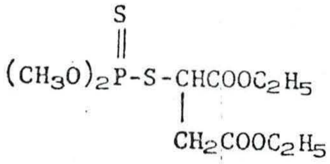


Dimethoate



$(CH_3O)_2\overset{S}{\overset{\|}{P}}-S-CH_2CONHCH_3$

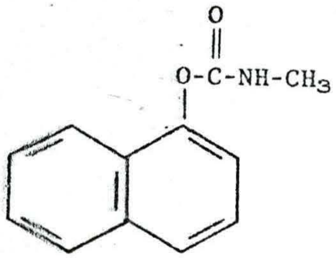
Malathion



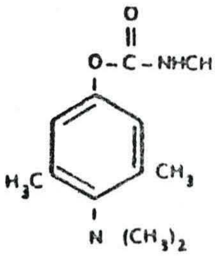
$(CH_3O)_2\overset{S}{\overset{\|}{P}}-S-\underset{\underset{CH_2COOC_2H_5}{|}}{C}HCOOC_2H_5$

C. Carbamate

Sewin

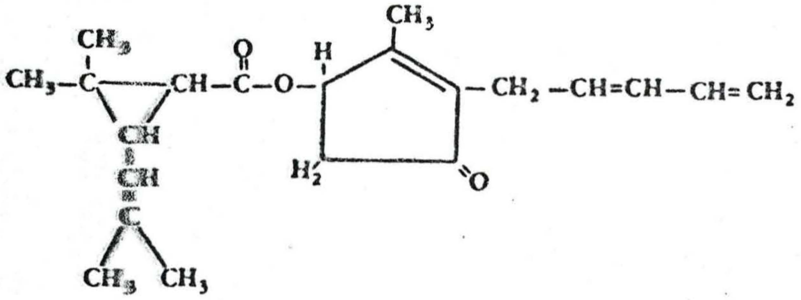


Zectran

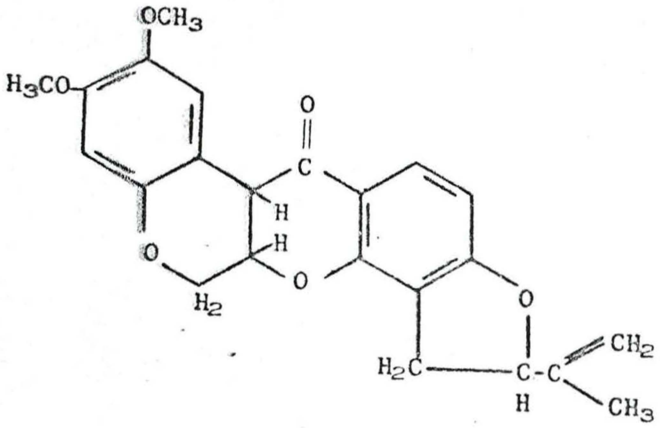


D. Botanical

Pyrethrum


CH3
CH3–C
CH–C–O–
O
H
CH3
CH2–CH=CH–CH=CH2
CH
CH
C
CH3
CH3
H2
O

Rotenone

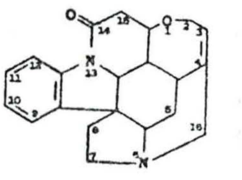

OCH3
H3CO
O
C
H
H
O
O
H2
O
H2C
C-C
H
CH2
CH3

I. Rodenticides

Zinc Phosphide

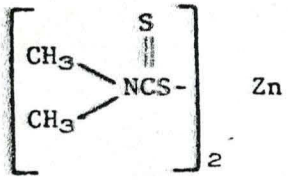
Zn_3P_2

Strychnine

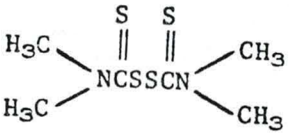


IV. Repellants (Protectants)

Ziram


S
CH3
CH3
NCS-
Zn
2

Thiram

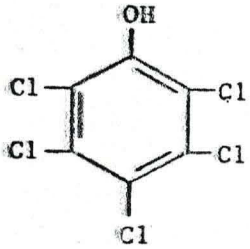

S S
H3C
H3C
NCSSCN
CH3
CH3

V. Fungicides

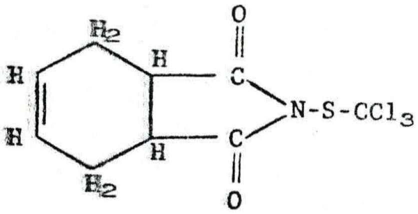
Methyl Bromide

CH_3Br

PCP


OH
Cl
Cl
Cl
Cl
Cl

Captan


O
H2
H
H
H
C
N-S-CCl3
H
C
H2
H
O

AMITROLE

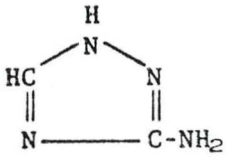
Names:

amitrole
ATA

Chemical Name:

3-amino, 1,2,4-triazole

Structure:



Manufacturer:

Amchem Products, Inc.
American Cyanamid Co.

Forest Use: Herbicide

A systemic non-selective herbicide for foliar application that is readily translocated, but absorbed very slowly from the leaves. It is used primarily for salmon berry and blackberry control in the coast range. It is not extensively used.

Toxicity:

Acute:

Mammal	Oral LD-50	14,700 - 24,600 mg/Kg
Bird		"Not toxic"
Fish		"Not toxic"

Chronic:

25 - 50ppm in two year feeding studies produces a goitrogenic response. That is, it enlarges the thyroid gland, and the effect is reversible upon withdrawal of the chemical and therefore not a carcinogenic effect.

Factors Affecting Movement:

Extremely water soluble, has a solubility of 28% or 280,000 ppm, but nevertheless is not particularly mobile in the soil as it is tightly bound by the organic matter in the soil.

Environmental Factors:

It is broken down readily by soil microorganisms and has a short residue life. The extremely high LD-50 [it is in the category of "relatively harmless" or more than 15g/Kg, which is even safer than "relatively non-toxic" (5 - 15 g/Kg)], suggests strongly that it is rapidly excreted, could not accumulate or be subject to biomagnification.

Mode of Action:

To Target Organisms:

Amitrole is absorbed and translocated to the young growing regions of the plant and produces a chlorosis with ultimate complete whitening of the plant. It affects chlorophyll production and formation of the chloroplasts. The process is slow and it may take two weeks for this to be accomplised.

AMITROLE-T

Names:

amitrole-T

Chemical Names:

3-Amino-1,2,3-triazole-plus
ammonium thiocyanate
(herbicide mixture)

Structure:

Amitrole + NH_4SCN

Manufacturer:

Amchem Products, Inc.
American Cyanamid Co.

Forest Use: Herbicide

Since amitrole-T is the same as amitrole, except that some ammonium thiocyanate has been added, it is essentially the same as amitrole. The purpose in adding the ammonium thiocyanate, which has some herbicidal properties, is to produce a greater effectiveness against certain plants.

Toxicity:

The major difference with regard to properties is that the acute oral toxicity of NH_4SCN is from 750-5000 mg/Kg. It is evident that the toxicity of the mixture is much greater than of amitrole.

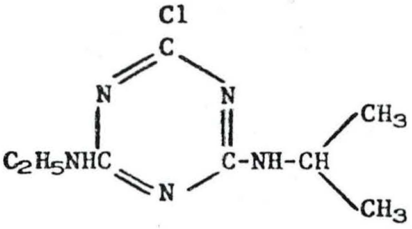
The ammonium thiocyanate poses no special environmental problems.

ATRAZINE

Names:

atrazine
AAtrex

Structure:



Chemical Name:

2-chloro-4-ethylamino-6-isopropylamino-s-triazine

Manufacturer:

Geigy Chemical Corporation

Forest Use: Herbicide

Atrazine is a selective herbicide absorbed principally through the roots, although some slow absorption through the leaves occurs. It is considered a selective herbicide, but the selectivity occurs as a result of soil placement and the fact that it does not move in the soil sufficiently to affect deeper rooted plants. It is used in forestry mainly to control grasses in forest plantations.

Toxicity:

Acute:

Mammal	Oral LD-50	1750 - 3800 mg/Kg
Bird		72,000 mg/Kg
Fish		"low toxicity"

Symptoms:

In animals:	ataxia, dyspnea, convulsions
In birds:	ataxia, tremors, weakness, and weight loss

Factors Affecting Movement:

Solubility in water is 70 ppm. It is adsorbed well on soil, and moves at a low to moderate rate. Twelve inches of rain may move the herbicide 9 or 10 inches. The vapor pressure is low and has not caused phytotoxicity problems.

Environmental Factors:

Atrazine is metabolized well by resistant plants, but only moderately by microorganisms and can persist at phytotoxic levels in soil from one to two years. It is metabolized rapidly by animals and is not accumulated.

Mode of Action:

To Plants:

Atrazine is translocated through the xylem from either the roots or foliage and accumulates in the apical meristem. It inhibits photosynthesis and causes chlorosis. There may be a number of other process and enzymes inhibited by atrazine.

CACODYLIC ACID

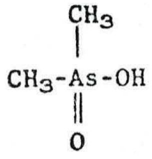
Name:

cacodylic acid

Chemical Name:

hydroxydimethylarsine oxide

Structure:



$$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{O}{\|}}{As}}-OH$$

Manufacturer:

Ansul Company

Forest Use: Herbicide

Cacodylic acid is a contact herbicide that will defoliate or dessicate a wide variety of plant species and is used in the forest as a silvicide applied by injection.

Toxicity:

Acute:

Mammal	Oral LD-50	520-830 mg/Kg
Bird		
Fish		

The mode of action and dermal penetration of the organic arsenicals and the fact that they are heavy metals poses more or a hazard to oeprators than many other compounds of a similar LD-50. Special care must be exercised in providing personal protection.

Symptoms:

Acute poisoning: Irritation of the GI tract, nausea, vomiting, diarrhea, and shock. Chronic poisoning: Exfoliation, skin pigmentation, herpes, polyneuritis, altered hematopoesis, and degeneration of the liver and kidneys.

Factors Affecting Movement:

Cacodylic acid is freely water soluble (83 gms/100 ml), but it is strongly adsorbed by soil particles and is essentially inactivated and not mobile. The fact that its use as a silvicide is by injection further limits its movement into the environment.

Environmental Factors:

Cacodylic acid is persistent and can accumulate in animals if it is available to them.

CAPTAN

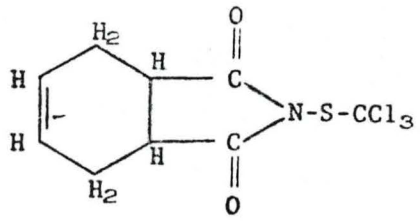
Names:

captan

Chemical Name:

N-trichloromethylmercapto-4-cyclohexexene-1,2-dicarboximide

Structure:



Manufacturer:

Chevron Chemical
Stauffer Chemical

Chemical Group:

Dicarboximide

Uses: Fungicide

Protectant against many fungus diseases of fruits, vegetables, ornamentals, and as a seed treatment. Not generally active against powdery mildew.

Phytotoxicity:

Not injurious to a great many living plants at recommended rates. Injury reported on some pear and apple varieties.

Compatibility:

Do not use with oil, alkaline materials, TEPP, and emulsifiable concentrates of Parathion. Do not use within four weeks of summer oil application.

Toxicity:

Acute:

Mammal	Oral LD-50	3,000 - 10,000 mg/Kg

Hazard:

Avoid contamination of animal feed and foodstuffs. May irritate skin. Avoid breathing in dust. Wear respirator and avoid captan contact with skin.

Symptoms:

Ingestion of large quantities may cause vomiting and diarrhea.

2,4-D

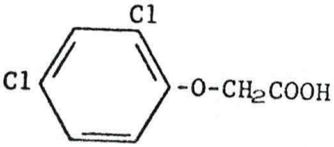
Names:

2,4-D

Chemical Name:

(2,4-dichlorophenoxy) acetic acid

Structure:



Manufacturer:

Dow Chemical Co.
Rhodia, Inc.--Chipman Division
Amchem Products, Inc.
Diamond Alkali Co.
Monsanto Co.

Forest Use: Herbicide

A selective herbicide used principally on broadleaf weeds and shrubs. It is used to control brush in release spraying, for brush field reclamation, and for hardwood control in general. It is also used as a silvicide in thinning operations.

Toxicity:

Acute:

Mammal	Oral LD-50	375 - 700 mg/Kg
Bird		340 - 2,000 mg/Kg
Fish	Oral LD-05	1 - 100 ppm

Not considered to be a hazard to man or wildlife, 6.5 grams toxic to an individual in suicide attempt. Principal effect on wildlife is alteration of habitat.

Symptoms:

Myotonia (in animals), stiffness of extremities, ataxia, paralysis, coma, hyporeflexia, fibrillary twitching, polydipsia, tachypnea, ptosis of eyelid, salivation, gastrointestinal and endocardial hemorrhages, anorexia, loss of weight, emesis. Death by ventricular fibrillation.

Factors Affecting Movement:

Vapor Pressure. Varies with the ester derivative. Low volatility with salts, amine formulations, and iso-octyl or butoxyethanol esters. High volatility with isopropyl or butyl esters ($4x10^{-4}$ to $9x10^{-6}$ mm). All derivatives have some volatility.

Leaching. Low solubility in water (50-150 ppm). Amongst the most mobile of the pesticides in leaching through soil, moving up to 6-8" with a rainfall of 50 inches.

Environmental Factors:

Persistence is low. Degraded by plants and soil microorganisms. Dissipates to below detectable levels (including volatility losses) from plants or soil in three to six weeks.

Accumulation in animals is neglible, being excreted within 48 hours for low doses and within a week for heavy doses. Animals withstand repeated sub-toxic doses for several months.

No biomagnification has been identified, due to rapid metabolism and excretion.

Mode of Action:

To Target Organisms:

A plant growth regulator type of herbicide with a systemic effect on plants. It is absorbed and translocated through both leaves (esters and salts) and roots (salts), though usually applied on the leaves. Following foliar absorptions it translocates within the phloem; after root absorption, it moves upward in the transpiration stream. The primary mechanism of action on the growing plant cells has not been clearly established, but respiration, food reserves, and cell division are affected probably through enzymes affecting oxidation and electron transport.

To Mammals:

Not well identified, but symptoms point to action on the nervous system.

DDT

Names:

DDT

Chemical Name:

2,2-bis (p-chlorophenyl)-1,1,1-trichloroethane

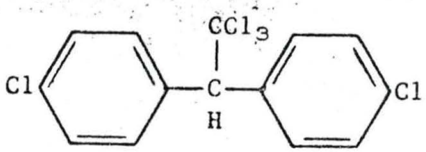
Manufacturer:

Montrose Chemical Co.

Forest Use: Insecticide

Previous registrations have been cancelled, and it is not presently registered for use against any forest insects. Any proposed use would have to be approved by the Environmental Protection Agency on a project basis. The OSFS has stated that the only pest for which alternative controls are not available is the Tussock Moth.

Structure:



Toxicity:

Acute:

Mammal	Oral LD-50	125 - 300 mg/Kg
Bird		607 - 2,240 mg/Kg
Fish	96 hr TM_m	0.5 - 50 pp billion

Chronic:

Birds	1 - 10 ppm (in diet)
Fish	0.1 - 50 ppb (in water)

Symptoms:

Acute, mammals: paresthesia of tongue, lip, face, and extremities, dizziness, confusion, tremors, and convulsion.

Acute, birds: ataxia, wing droop, jerkiness in gate, tremors, convulsions.

Chronic: many manifestations in birds and fishes; decrease in growth rate, decreased litter size, fertility hatchability, decreased thermal and salt adaptability (in fishes) and eggshell thinning (in birds).

Factors Affecting Movement:

DDT has an extremely low water solubility (1.2 parts per billion) and vapor pressure (1×10^{-7} mm Hg), but nevertheless moves very well in the environment. The low water solubility is at a level which can cause toxicity to fish and does not prevent much larger amounts from being carried adsorbed on soil or organic particulate. The low vapor pressure does not prevent a significant fraction of the deposit from volatilizing. A very important factor in environmental movement is the high lipid/water partition ratio and the relatively slow rate of metabolism of DDT and one of its metabolites (DDE).

Environmental Factors:

The hazard to the applicator is very slight and environmental exposure of men has not resulted in any identifiable harmful effects. However, DDT can cause harmful effects to wildlife--particularly birds and fishes. Although there is some disagreement as to the extent of the effects caused by DDT, such as eggshell thinning, there is agreement that DDT is a factor in this problem and there is agreement that DDT is accumulated by a number of species at levels which are a basis for concern.

Mode of Action:

Acute. A central nervous system poison which probably acts by adsorption on the neuron and permits uncontrolled nerve pulses to be generated within the nerve. This is in contrast to the organophosphorous esters which are also nerve poisons, but inhibit an enzyme at the junction between two nerves.

DIAZINON

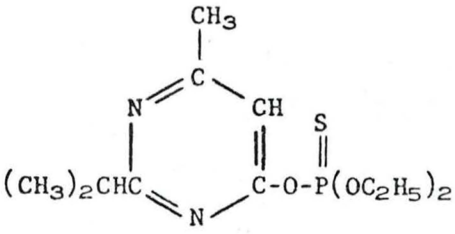
Names:

Diazinon

Chemical Name:

O,O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothiate

Structure:



Manufacturer:

Geigy Chemical Co.

Chemical Group:

Organophosphorus ester

Uses: Insecticide

On vegetables, fruit, ornamentals, forage crops, and for cockroach control. No systemic action.

Phytotoxicity:

Do not use on gardenia, hibiscus, poinsettia, stephanotis, African violets. Will russet many apple varieties.

Compatibility:

Do not use with copper fungicides.

Toxicity:

Acute:

Mammal	Oral LD-50	76 - 150 mg/Kg
	Dermal LD-50	455 - 900 mg/Kg
Bird		2 - 6 mg/Kg

Hazard:

Do not use directly on birds or livestock. Applicator should wear protective clothing: absorbed through skin. Ducks and geese are especially susceptible to diazinon.

Symptoms:

Man:

Typical symptoms--miosis, bradycardia, diarrhea, increased respiratory tract secretions, coma, and convulsions.

Bird:

Goose-stepping ataxia, wing spasms, wing droop, hunched back, dyspnea, tenesmus, diarrhea, salivation, lacrimation, ptosis of eyelid, prostration, opisthotonos-like seizures or wing-beat convulsions.

Mode of Action:

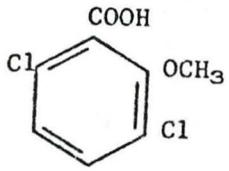
Diazinon and other organophosphorus esters are nerve poisons which inhibit the cholinesterase enzyme at the neural synapse, or junction box between two nerves, and allows the chemical mediator acetyl choline to continue the generation of nerve pulses. Chronic toxicity is manifested by only two or three O-P compounds and results in demulination of the nerve sheath. The O-P esters in forest use do not do this, and exhibit no chronic effects, although frequent subacute doses may depress the cholinesterase to below the threshold level, resulting in acute mortality.

DICAMBA

Names:

dicamba
Banvel D

Structure:



Chemical Name:

3,6-dichloro-o-anisic acid

Manufacturer:

Velsicol Chemical Corporation

Forest Use: Herbicide

Control of some phenoxy-tolerant annual and perrenial broadleaf and grassy weeds and brush species. It has been examined as a possible replacement for 2,4,5-T, but has not been used extensively.

Toxicity:

Acute:

Mammal Oral LD-50	
Acid	2,100 - 3,700 mg/Kg
Dimethyl amine salt	566 - 1,028 mg/Kg
Bird	673 - 800 mg/Kg
Fish	
(96 hr TL_m) acid	23,000 - 28,000 ppm
48 hr TLM dimethyl amine salt	465 ppm

No hazard to man or wildlife detected, and it is a relatively safe compound.

Symptoms:

Factors Affecting Movement:

The salt has a water solubility of 7900 ppm and is, therefore, quite water soluble in relation to most pesticides. It is quite mobile in the soil. The vapor pressure is very low, and only insignificant losses occur through volatility.

Environmental Factors:

It persists in soil for about two months, or slightly longer than 2,4-D.

It is rapidly excreted in the urine of animals. Animals withstand repeated sub-toxic doses. Eight hundred ppm (of the acid) fed to rats for three months produced no adverse effects, and 500 ppm fed for two years produced no effects.

The rapid rate of excretion by animals suggests that no biomagnification could occur.

Mode of Action:

To Target Organisms:

Dicamba is a growth regulating chemical which is readily absorbed and translocated from roots or foliage. It produces effects similar to those found with 2,4-D, but the biochemical processes affected have not been identified.

DIMETHOATE

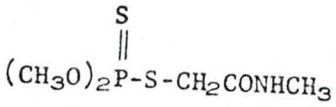
Names:

dimethoate
cygon

Chemical Name:

O,O-dimethyl S-(N-methylcarbamoylmethyl)-phosphorodithioate

Structure:



$$(CH_3O)_2\overset{\overset{S}{\|}}{P}\text{-}S\text{-}CH_2CONHCH_3$$

Manufacturer:

American Cyanamid

Chemical Group:

Organophosphate

Uses: Insecticide

A systemic insecticide against sucking insects and mites on vegetables, and a residual fly spray. Contact as well as systemic action.

Phytotoxicity:

Do not use on chrysanthemums, ornamental prunus species such as flowering cherries or on plums or hops. Use on trial basis for first time on every ornamental. Injury also reported on walnuts, peaches, figs, tomatoes, cotton, beans, and many ornamentals.

Compatibility:

Do not mix with alkaline materials.

Toxicity:

Acute:

Mammal	Oral LD-50	215 - 250 mg/Kg
	Dermal LD-50	400 - 700 mg/Kg
Bird	Oral LD-50	30 - 60 mg/Kg

Hazard:

Moderate. Avoid drift onto livestock and feed. Will kill bees.

Symptoms:

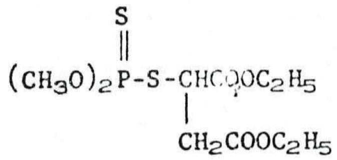
Birds: Feathers drawn tightly to the body, mild tachypnea, ataxia, myasthenia, tremors.

MALATHION

Names:

Malathion
carbophos

Structure:



$$(CH_3O)_2\overset{\overset{S}{\|}}{P}-S-\underset{\underset{CH_2COOC_2H_5}{|}}{CH}COOC_2H_5$$

Chemical Name:

O,O-dimethyl S-1,2-di (ethoxycarbamyl) ethylphosphorodithioate

Manufacturer:

American Cyanamid

Chemical Group:

Organophosphate

Uses: Insecticide

As a generally safe, broad-spectrum organophosphate; contact action. On fruit, vegetables, ornamentals, forage, livestock and poultry, fly control.

Phytotoxicity:

Do not use on ferns, crassulas, petunias, and orchids. May injure certain varieties of apples, pears, cranberries, sweet cherries, grapes, and string beans. Will spot fruit of nectarines.

Compatibility:

Do not use with alkaline materials. Reacts with heavy metals, especially iron.

Toxicity:

Acute:

Mammal	Oral LD-50	570 - 1,650 mg/Kg
	Dermal LD-50	4,000 mg/Kg
Birds		1,020 - 2,150 mg/Kg

Hazard:

Generally low when used as directed. Applicator caution necessary when using concentrated form. Concentrate will spot automobile finishes.

Symptoms:

Man: Similar in poisonings of other organic phosphorus compounds; however, sudden coma (characterized by unconsciousness and marked flaccidity of limbs, but without cardio vascular collapse and with minimal interference with respiration). Four grams produced severe but non-fatal illness in child, and 14 g. had a similar effect on a woman. Yet 5 g. led to death of 75-year-old man about 1.5 hours after ingestion.

METHYL BROMIDE

Name:

Methyl bromide

Structure:

$\boxed{CH_3Br}$

Chemical Name:

Methyl bromide

Manufacturer:

Dow Chemical Co.

Forest Use: Fungicide

Soil fumigant for nursery stock beds. Controls all types of living things - disease organisms, insects, weed seeds, plant tissue, nematodes, etc.

Toxicity:

Inhalation lethal concentration

Man	35 ppm
Guinea pig	300 ppm
Rat	2000 ppm

Maximum allowable concentration in air is 17 ppm.

Symptoms:

Methyl bromide produces an indifferent narcosis (Nussbaum's narcosis) which can proceed from malaise, headache, dizziness, double vision, nausea, ataxia, emesis, tremors, convulsion, pulmonary edema, to stupor.

MSMA

Names:

MSMA

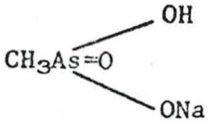
Chemical Name:

monosodium acid methanearsonate

Manufacturer:

Ansul Company
Amchem Products, Inc.

Structure:



Forest Use: Herbicide

MSMA is a foliar herbicide which is used as a silvicide by injection.

Toxicity:

Acute:

Mammal	Oral LD-50	700 - 1800 mg/Kg
Bird		
Fish		

The mode of action and dermal penetration of organic arsenicals and the fact that they are heavy metals poses more of a hazard to operators than many other compounds with similar LD-50 values. Special care must be exercised in providing personal protection.

Symptoms:

Subacute poisoning: salty taste, burning in the throat, colicky, pains in the stomach and intestines, and frequently a garlic odor on the breath and skin. Acute poisoning: headache, vomiting, diarrhea, dizzyness, stupor, convulsions, and general paralysis.

Factors Affecting Movement:

MSMA is freely water soluble, about 75% w/v but is strongly adsorbed on soil particles and is not mobile. The nature of the use in the forest, ie. injection as a silvicide, further precludes movement in the environment.

nvironmental Factors:

MSMA is persistent in the environment, because it is an arsenical. It can accumulate in animals as it has a longer retention time than most herbicides.

Names:

PCP

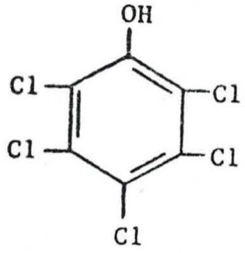
Chemical Name:

Pentachlorophenol

Manufacturer:

Dow Chemical
Monsanto Chemical Co.
Chipman Chemicals, Ltd.

Structure:



Formulations:

85% and 88% wettable powder; 5%, 21%, and 41% solutions, and 40% flakes

Uses: Fungicide

A contact herbicide applied both preemergence and postemergence as well as an insecticide and fungicide.

Physical Properties:

White (pure form), light green granules with a low water solubility (20 ppm).

Toxicity:

Acute:

Mammal	Oral LD-50	27 - 140 mg/Kg
Fish	LC-50	0.2 - 0.6 ppm

Hazards:

Avoid contact, since this compound is absorbed through the skin especially from oil solutions. Provide personal protective gear.

Symptoms:

Increased respiration and pulse rate; hypoglycaemia, diuresis, oliguria.

PICLORAM

Names:

picloram
Tordon

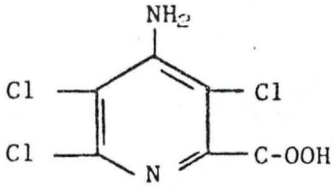
Chemical Name:

4-amino-3,6-trichloropicolinic acid

Manufacturer:

Dow Chemical Company

Structure:



Forest Use: Herbicide

Picloram is a selective herbicide for broadleaf plants and is used for woody brush control and deep rooted weeds. In forestry it is used for brush field reclamation and rights-of-way maintenance, and occasionally used as a silvicide.

Toxicity:

Acute:

Mammal	Oral LD-50	2,000 - 8,200 mg/Kg
Bird		6,000 - 20,000 mg/Kg
Fish	(96 hr TL_m)	20 - 100 ppm

Symptoms:

Nausea.

Factors Affecting Movement:

The water solubility of picloram acid is 430 ppm, but the salts are quite soluble and it is usually formulated as a potassium or amine salt, though occasionally as an ester. It is fairly mobile in the soil. The vapor pressure is low and phytotoxicity problems from vapor movement are not a problem.

Environmental Factors:

Picloram is more persistent than most herbicides. The half life is given as six to seven months, compared to one to four months for most herbicides. It has been shown to decline by 35% in six months in the forest environment, suggesting a half life of about nine months. The persistence problem is aggravated by the fact that it has a much greater range of sensitivity to some broadleaf plants than most herbicides. Very low levels (a few parts per billion) can cause malformed growth on such plants as potatoes or beans. This results in unwanted effects in some situations persisting for as long as seven or eight years. It can be carried by runoff in sufficient amounts to severly damage susceptible plants.

Tordon is excreted rapidly and is not accumulated, and biological magnification apparently does not occur.

Mode of Action:

To Plants:

Picloram is readily absorbed by both roots and foliage and is translocated both up and down and accumulates in the new growth. It is a growth regulator, but the mode of action has not been established.

PYRETHRIUM

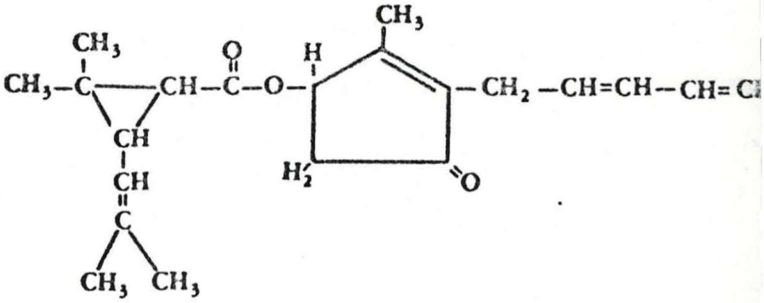
Name:

Pyrethrium

Chemical Name:

2,2-dimethyl-3,2(-2-methylpropenyl) cyclopropanecarboxylix acid ester with 4-hydroxy-3-methyl-2-(2,4-pentadienyl)-2-cyclopenten-1-one

Structure:



Manufacturer:

McLaughlin, Gormley, King & Co.

Chemical Group:

Organic botanical (plant derived)

Uses: Insecticide

As a contact household, livestock, and home garden spray.

Phytotoxicity:

No plant injury recorded.

Compatibility:

Breaks down rapidly in the presence of alkaline materials, sulfur, soaps, and in sunshine.

Toxicity:

Acute:

Mammal	Oral LD-50	570 mg/Kg
Bird		10,000 mg/Kg
Fish		10 - 20 ppm

Symptoms:

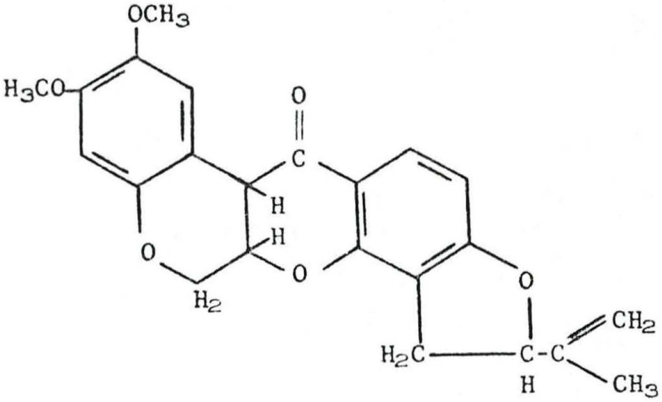
Bird: possible slight weakness lasting a few hours, and regurgitation.

ROTENONE

Names:

rotenone
Derris

Structure:



Chemical Name:

$C_{22}H_{22}O_6$

Manufacturer:

Malinckrodt

Chemical Group:

Organic botanical
(plant derived)

Uses: Insecticide

As a safe home garden contact insecticide for use on vegetables, livestock, flea powder for cats and dogs.

Phytotoxicity:

Not generally damaging to plants.

Compatibility:

Not used with alkaline materials, breaks down in the presence of bright sunlight. Do not use on white-wash.

Toxicity:

Acute:

Mammal	Oral LD-50	145 mg/Kg
	Dermal LD-50	940 mg/Kg
Birds		1,414 - >2,000 mg/KG
Fish		0.01 - 0.10 ppm

Hazard:

Generally low. Do not use on pigs or where pigs may contact treated commodities. Rotenone is highly toxic to fish and all precautions should be taken to prevent drift onto fish ponds. May injure other small mammals such as rabbits.

Symptoms:

Birds:

Ataxia, nutation, dyspnea, polyuria, feathers fluffed or held tightly to body, wing droop, neck pulled in, immobility. Regurgitation occurs at levels above 1,500 mg/Kg.

Mammals:

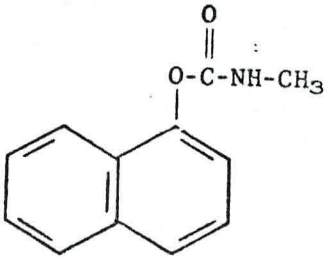
Numbness of the oral mucous membrane, nausea, vomiting, tremors, tachypnea, convulsions, respiratory paralysis.

SEVIN

Names:

Sevin
carbaryl

Structure:



Chemical Name:

N-Methyl-2-naphthyl carbamate

Manufacturer:

Union Carbide Corporation

Chemical Group:

Carbamate

Uses: Insecticide

As a residual, contact and stomach poison insecticide. Not effective against sucking insects. Spray application equipment must have continuous agitation. General usage in field, forage, vegetable crops, livestock insects, and poultry houses.

Phytotoxicity:

Low. Will cause leaf drop of cotoneaster and Boston ivy; severe leaf spotting on Cortland and McIntosh apples; and thinning of fruit. May retard grass germination. May injure watermelon.

Compatibility:

Not compatible with lime, Bordeaux mixture, lime-sulfur or other alkaline materials. When mixing Sevin wettable powder with emulsifiable concentrates and other pesticides, small batches should be tested first to make sure they are physically compatible.

Toxicity:

Acute:

Mammal	Oral LD-50	200 - 400 mg/Kg
	Dermal LD-50	500 mg/Kg
Bird		707 - 2,290 mg/Kg

Hazard:

Usually low. Carbaryl, however, is extremely poisonous to bees and every attempt should be made to safeguard them. Carbaryl is not effective against mites and these may build up after the use of carbaryl. Do not use on fruit trees at blossom time if these are to be thinned with another chemical.

Symptoms:

Atoxia, weakness, salivation, tachypnea, tremors, tetany, paralysis, coma, convulsions.

Mode of Action:

The carbamate insecticides act in a very similar manner to the organophosphorus esters. they are nerve poisons which inhibit cholinesterase. Symptoms are much the same as with O-P compounds.

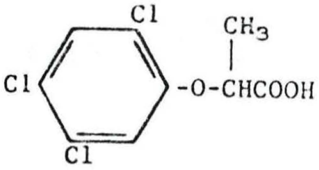
Names:

silvex
fenoprop
2,4,5-TP

Chemical Name:

2-(2,4,5-Trichlorophenoxy) propionic acid

Structure:



Manufacturer:

Dow Chemical Company

Forest Use: Herbicide

Less selective than 2,4-D but controls some plants better than 2,4-D or 2,4,5-T. Used in brush control and occasionally for thinning, and as a basal trunk treatment or by injection.

Toxicity:

Acute:

Mammal	Oral LD-50	650 mg/Kg
Bird		2000 mg/Kg
Fish		

Not considered a hazard to man or wildlife. Similar to 2,4-D, but slightly less toxic.

Symptoms:

Same as 2,4-D for mammalian responses, causing nausea, vomiting, lethargy, and incoordination. In birds the response is ataxia, minor temors, wings crossed high over back and tail pointing up or down (a form of myotonia), and walking high on the toes. Onset of symptoms in birds occurred at 500 mg/Kg.

Factors Affecting Movement:

The molecular structure is like 2,4,5-T except that it has one more methyl group in the side chain. This would slightly reduce the vapor pressure and water solubility.

Mode of Action:

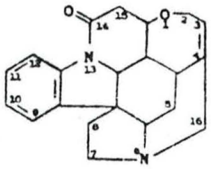
Same as 2,4-D and 2,4,5-T, interferring with the process of cell diferentiation.

STRYCHNINE

Names:

strychnine

Structure:



Chemical Name:

$C_{21}H_{22}N_2O_2$

Manufacturer:

Malinckradt

Chemical Group:

Alkaloid (derived from the seeds of the Strychnos plant)

Uses: Rodenticide

As a dry bait for killing mice, porcupines, rabbits, squirrels, and other rodents. Not effective against rats unless the bitter taste of the Strychnine is overcome by the addition of syrup or other Strychnine-masking materials. Single baiting usually all that is needed for each infestation. Fast acting. Bait shyness will develop.

Compatibility:

Slightly soluble in water; nonflammable; odorless; slight deterioration in baits occurs.

Toxicity:

Acute:

Mammal	Oral LD-50	1 - 60 mg/Kg
Bird		2.0 - 22.6 mg/Kg

Hazard:

To the applicator, moderate; no absorption through the skin occurs; avoid breathing in dust. Secondary poisoning of cats and dogs possible if Strychnine is still present in stomach of the animal eaten. Do not place baits in areas where children or birds are likely to eat them. Effectiveness of Strychnine is reduced with repeated usage in an area.

Symptoms:

Birds: Feathers fluffed or held tightly against body, low or high carriage, ataxia or asynergy, fasciculation, wing drop, tails pointed down, salivation, tremors, hyperacusis, muscle tenseness, recurring convulsions or tetanic seizures, anorexia, tachycardia, immobility, violent convulsions or opisthotonos.

2,4,5-T

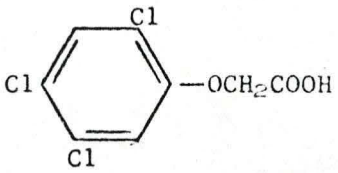
Names:

2,4,5-T

Chemical Name:

2,4,5-Trichlorophenoxyacetic acid

Structure:



Manufacturer:

Amchem Products, Inc.
Dow Chemical Co.
Monsanto Co.

Forest Use: Herbicide

A selective herbicide, similar in action to 2,4-D, used principally on broadleaf plants. It is more effective than 2,4-D on woody plants and hence useful in brush sprayings for conifer release, brush field reclamation, and for hardwood control. It is also used as a silvicide in thinning operations.

Toxicity:

Acute:

Mammal	Oral LD-50	
Rat		481 - 500 mg/Kg
Dog		100 mg/Kg
Bird		
Fish 48		
(48 hr TL_m)		1 - 100 ppm

Not considered hazardous to man or wildlife. Slightly more toxic than 2,4-D. An impurity which is produced during manufacture, tetra chloro dioxin, is extremely toxic, but production is regulated so that 2,4,5-T will contain less than 0.5 ppm of the impurity. Thus, if there is 1 ppm of 2,4,5-T deposited on an environmental substrate, there would be 0.000,000,5 ppm (or 0.5 parts per trillion) of the dioxin. The dioxin degrades more slowly than 2,4,5-T, and would tend to be present at relatively higher ratios with time. No hazard to man or wildlife is expected to result from these low levels but continuing study is indicated.

Symptoms:

Similar to 2,4-D, but with less pronounced myotonia or only mild spastic effects or some incoordination.

Factors Affecting Movement:

Vapor Pressure. The vapor pressure varies with the derivative, but is lower than 2,4-D--probably by 1/2 to 1/10. It does have sufficient volatility to cause injury to sensitive crops adjacent to sprayed areas.

Leaching. The water solubility of the acid is 200 to 280 ppm compared to 400 to 900 ppm for 2,4-D acid, therefore the solubility of comparable esters would be similarly reduced--probably ranging from 1/3 to 1/2 that or 2,4-D or 20 to 50 ppm. Rate of movement in soil would be similarly affected relative to 2,4-D.

Environmental Factors:

Persistence is longer than for 2,4-D, but still considered low. It persists in soil for five months compared to one month for 2,4-D (to decline to about 5% of initial deposit, or a negligible level).

Accumulation in animals is negligible, as it is metabolized and excreted rapidly as is 2,4-D. Animals show no effects from repeated sub-toxic doses for several months. High levels of dosage have been reported to cause birth deformities and cancer in susceptible strains of mice by some investigators, but this has been disputed by other investigators. A careful assessment of the data by a National Academy of Sciences committee found that no hazard exists from forest spray operations.

Biomagnification has not been found to occur and no harmful effects to wildlife have been detected.

Mode of Action:

To Target Organisms:

2,4,5-T is a plant regulator type of herbicide which translocates from the foliage and roots as is 2,4-D. The difference in activity to woody plants is thought to be due to difference in absorption and translocation and particularly to the fact that the plant metabolizes it more slowly than 2,4-D.

To Mammals:

Not well identified, but symptoms point to effects on the nervous system.

THIRAM

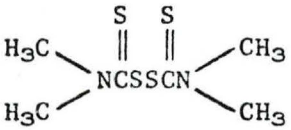
Names:

thiram
Arasan

Chemical Name:

tetramethylthiuram
disulfide

Structure:



Manufacturer:

DuPont
Merck

Forest Use: Repellents

Used for rabbits, deer, squirrels, and mice. In other circumstances it is used as a fungicide for disease control.

Toxicity:

Acute:

Mammal	Oral LD-50	350 mg/Kg
Bird		673 - >2,800 mg/Kg

Symptoms:

Mammals:

Headache, drowsiness, fatigability, or dermatitis. Closely related to anti-alcoholic drugs and consumption of spirits before or after exposure is contra-indicated.

Birds:

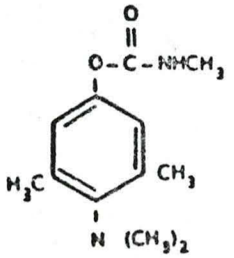
Mallards showed transient ataxia only. Pheasants showed tachypnea, wing droop, reluctance to move, fluffed feathers, ptosis of the eyelid, diarrhea, tremors like those produced by chlorinated organic compounds, immobility.

ZECTRAN

Name:

Zectran

Structure:



Chemical Name:

4-dimethyl-3,5-xylyl
methylcarbamate

Manufacturer:

Dow Chemical Company

Forest Use: Insecticide

Registered for use against the spruce budworm and in the experimental, developmental stages for control of Douglas-fir Tussock Moth.

Toxicity:

Acute:

Mammal	Oral LD-50	15-30 mg/Kg
Bird		2-50 mg/Kg
Fish		

Symptoms:

Ataxia, neck tremors, nystagmus, miosis, tachypnea, dyspnea, lacrimation, salivation, diarrhea, tachycardia, tracheal congestion, elevated body temperature, terminal convulsions. Increased respiratory rate. Death appears to occur by respiratory paralysis.

Environmental Factors:

Considered to pose no hazard to wildlife in forest use. Despite its high toxicity, birds and wildlife tolerate subacute doses well, and it breaks down rapidly and is not cummulative.

ZINC PHOSPHIDE

Names:

zinc phosphide

Structure:

$\boxed{Zn_3P_2}$

Chemical Name:

zinc phosphide

Manufacturer:

Hooker Chemical Co.

Chemical Group:

Inorganic

Uses: Rodenticide

As a rat, mice, gopher, squirrel, and bird killer in dry or fresh baits. Bait should be placed where rodents will find it. Remove bait two days later. Should be used at intervals of one month to one year as needed. Fast acting; breaks down in the presence of moisture within 72 hours.

Compatibility:

Insoluble in water; soluble in oil; slightly corrosive to metals; stable when dry; bait deteriorates within two weeks. Shelf life of baits limited. Store in dry place.

Toxicity:

Acute:

Mammal	Oral LD-50	40 - 47 mg/Kg
Birds		65 mg/Kg

Hazard:

High. In general, the pungent garlic odor is repellent to animals and can be detected arising from the intestinal content of poisoned animals. Addition of tartar emetic to cause vomiting reduces the possibility of accidental poisoning. Hazard to applicator is moderate. Black powder--no absorption through the skin; do not breathe dust or vapor; no likelihood of secondary poisoning of cats and dogs which have eaten poisoned rodents.

ZIP

Names:

Zip
Ziram

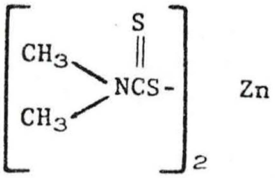
Chemical Name:

Zinc dimethyldithiocarbamate

Manufacturer:

DuPont

Structure:



Forest Use: Repellent

Used as deer and rabbit repellent in new plantings. Under other circumstances is used as a fungicide.

Toxicity:

Acute:

Mammal	Oral LD-50	1,400 mg/Kg

Symptoms:

See Thiram. Ingestion of alcohol after ziram administration causes intense vasodilation of face and neck, tachycardia and tachypnea followed by nausea, vomiting, pallor, hypotension. Occasionally convulsions, cardiac arrhythmias, myocardial infarction may occur. May cuase irritation of skin and mucous membranes, and renal damage.

GLOSSARY

Anorexia	Loss of appetite for food
Ataxia	Loss of muscular coordination
Carcinogenic	Causes cancer
Dyspnea	Shortness of breath
Emesis	Vomiting
Exfoliation	A falling off in scales or layers
Fasciculation	A small local contraction of muscles, visible through the skin
Hematopoesis	Formation of blood cells
Herpes	Eruption of skin sores
Hypoglycemia	Low glucose content in the blood
Hyporeflexia	Weakening of the reflexes
Miosis	Contraction of the pupil
Myasthenia	Muscular debility, excessive weakness
Myotonia	Contraction or tonic spasm of the muscle
Nausea	An unpleasant sensation, vaguely connected with the stomach and abdomen
Nutation	A nodding to-and-fro movement
Nystagonaus	Involuntary, rapid eyeball movement
Opisthotonus	A tetonic spasm in which the back, neck, and heels are severly arched
Paresthesia	An abnormal sensation of prickling or burning
Polydipsia	Excessive drinking
Polyneuritis	Inflamation of many nerves at once
Polyuria	The passage of a large volumn of urine

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